Dogs demonstrate memory of incidentally encoded information

Sarah Krichbaum¹ · Jeffrey S. Katz¹

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Summary

Fugazza, Pongrácz, Pogány, Lenkei, and Miklósi (*Scientific Reports*, 10(1), 1–8, 2020) recently showed that dogs can repeat incidentally encoded behaviors using unexpected tests. These results suggest that dogs may possess episodic-like memories for their own actions.

Episodic memory can be defined as memory for one's own actions and is indicative of higher level thinking, including the ability to problem solve (Tulving, 1985). Studies on episodic memory in humans typically rely on verbal reports of mental time travel (or the ability to travel back in one's own mind to relive an experience). Tulving (1985) claimed that, due to the inability of nonhumans to verbally report episodic memories, the process must be uniquely human. However, animal cognition researchers devised new procedures that challenged Tulving's idea and uncovered evidence of episodic-like memory processes in nonhumans (Templer & Hampton, 2013).

One of the methods designed for assessing episodic-like memory in nonhumans (Zentall, Singer, & Stagner, 2008), the “surprise” test, must be completely unexpected to claim that an animal is demonstrating episodic-like memory. Zentall and colleagues reasoned that if the test scenario is preceded by trained stimulus–response contingencies, especially in the same context as the test, it is likely that the animal acquires expectations regarding the future test. These expectations allow the animal to plan for the test by explicitly encoding necessary information. In other words, the information is essentially carried forward to be used on the test and does not require the animal to remember an earlier episode. Therefore, the desired information must arise from incidental encoding, which occurs when the context is devoid of any cues that the information will be needed in the future (Zentall et al., 2008; Zhou, Hohmann, & Crystal, 2012). Then, at the unexpected test, the only way the animal can retrieve the information is

through episodic-like memory of the incidentally encoded event.

In a landmark study, rats were trained on two tasks to assess episodic-like memory for the presence of food (Zhou et al., 2012). In a radial arm maze, rats were required to search for food at the end of three arms, and in a T-maze, they had to choose which arm to search (left or right) after being presented with the presence or absence of food at the sample position (e.g., if food, then turn left). Then, in an unexpected test, rats were required to search in three arms of the radial arm maze, however, either all or none of the arms contained food. Next, the rats were placed in the T-maze, with nothing in the sample position, and had to choose which arm (left or right) to search. This test was unexpected because rats were never required (through stimulus–response contingencies) to remember if the radial arm maze contained food. Rats were successful at choosing the correct arm based on whether they had encountered the presence or absence of food in the radial arm maze. Zhou and colleagues concluded that the high level of performance on the unexpected test was due to episodic-like memory of incidentally encoded information and urged the field to expand the use of the “surprise” test to other species.

In a recent study, Fugazza et al. (2020) extended on their previous attempt to examine dog episodic memory by creating unexpected tests that were free of training cues. Ten pet dogs were trained to repeat a set of behaviors (e.g., sit) with the “repeat” command. Then, after the dogs were reliably repeating trained behaviors, dogs completed a series of 12 tests. A set of expected tests were used to assess if dogs could repeat trained (i.e., baseline) and untrained behaviors (i.e., untrained actions repeat test), and control for other explanations of the repeat behavior (i.e., doing nothing test, Clever Hans control, and ‘who is acting’ test). While a set of unexpected tests were used to assess the dogs’ ability to repeat behaviors in everyday life situations that occurred separate from the training context

✉ Sarah Krichbaum
szk0138@auburn.edu

¹ Department of Psychological Sciences, Auburn University, 226 Thach Hall, Auburn, AL, USA

and were devoid of any training cues (i.e., spontaneous action and spontaneous object-action tests). Control conditions for these tests included the spontaneous action control, spontaneous object action control, different word control, spontaneous action word control, and control for context.

In the spontaneous action test, the owners were instructed to give their dog the repeat command after their dog committed a recognizable (e.g., lay down on the couch) but previously untrained behavior, and in the spontaneous object action test, four novel objects were placed in a familiar area of the house, and the owners were instructed to give their dog a repeat command after their dog committed a recognizable (e.g., picked up an object with their mouth) but previously untrained behavior towards one of the objects. Each of these tests were also performed with delays (20 s, 1 min, and 1 hour) between the recognizable behavior and the repeat command in order to determine if memory for the untrained behavior was affected by delay. The results of both unexpected tests indicated that 7/10 dogs successfully repeated their own actions although there was a significant decrease in repeatability across delays. The authors concluded that the high level of performance on the unexpected tests suggests that dogs can display episodic-like memory of incidentally encoded information regarding their own actions.

The researchers of the current study went to great lengths to ensure that the spontaneous tests were unexpected. For example, the spontaneous tests were carried out in the owner's house in order to remove any cues that related to previous training (which occurred in a different context) of the repeat command. In addition, the owners were asked to act naturally (e.g., sit on the couch on their phone) and to only ask their dog to repeat a recognizable, untrained behavior. Therefore, it is unlikely that dogs relied on any cues to explicitly encode the untrained behaviors. However, explicit encoding can also be triggered by the repetition of unexpected tests or the formation of stimulus-response contingencies. For example, on a task to examine episodic-like memory in pigeons, probe trials in which the pigeon was required to respond to a colored key based on where they had last pecked were dispersed infrequently amongst baseline trials in order to ensure that successful responses were not due to the formation of semantic rules learned through explicit encoding (Zentall et al., 2008). In the current study, each test occurred only once and their order was randomized for each dog, but the delay versions of each test were the same as the non-delay version except for the delay period. Therefore, it is possible that following the first unexpected test (spontaneous action and spontaneous object-action test) of each type, dogs could have expected the test to occur

and prepared by explicitly encoding behaviors while in that context. Future studies in dogs should report accuracy on the first unexpected test to demonstrate memory of incidentally encoded behaviors and whether changes in performance occurred over the testing trials.

While these results do not clearly represent episodic-like memory, they provide an impressive step toward a better understanding of incidentally encoded information and the mental representation of own actions in dogs. Future work should focus on other aspects of episodic-like memory (e.g., in-context and what-where-when memory), as a well rounded view is important for developing the theory of episodic-like memory and its comparability across species. For example, there are still questions regarding the importance of context in episodic-like memory. Notably, the current work contained a condition in which the dogs exhibited a recognizable behavior before being asked to repeat the behavior in a different context and the results indicated that none of the dogs were successful at repeating the behavior in the new context. This contrasts the findings mentioned above, that showed rats remembered if food occurred in a different context (Zhou et al., 2012). Future investigations, consisting of systematically varying contexts, would help determine the importance of context in episodic-like memory. These advancements would urge the field to more deeply assess these functions and provide knowledge on the role of episodic-like memory in everyday life.

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